

PARASITES FROM EAST-COAST AUSTRALIAN BILLFISH

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Fifty-two sailfish, *Istiophorus platypterus*, and 63 black marlin, *Makaira indica*, were examined for parasites between 1987 and 1989. Sailfish were collected from 4 locations along the Queensland coast between Cape Moreton in the south and Dunk Island in the north. Black marlin were sampled from a similar range, but extending further north to Lizard Island where large fish, in excess of 450kg, were available. Thirty-one parasite species were identified from sailfish (22 new records) and 28 from black marlin (20 new records). Twenty-four species were shared by sailfish and black marlin. Parasites were also collected from 1 blue marlin, *Makaira mazara*, and 3 striped marlin, *Tetrapterus audax*, taken off Cape Moreton. Ten species of parasites were identified from the blue marlin (6 new records) and 5 from striped marlin (2 new records). Gut analysis revealed a more diverse diet for the sailfish which was reflected in their parasite fauna. □ *Istiophorus*, *Makaira*, parasites, Queensland, Australia.

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Records of parasites from billfishes have usually come from more general surveys of fishes by parasitologists focusing on specific taxa. Prior to this study, 19 species of parasites had been recorded from Pacific sailfish, *Istiophorus platypterus*, and 13 from black marlin, *Makaira indica*.

This report presents the results of an intensive survey of the parasite fauna of sailfish and black marlin along the coast of Queensland, NE Australia. Numerical analyses of the parasites as biological tags were documented in Speare (1994, 1995). This report focuses on ecological notes on these parasites, distributions of parasites on the hosts, and some pathology. Possible sources of infection are discussed based on knowledge of the feeding habits of hosts.

METHODS

All fish were obtained from recreational fishing activities. Fish were collected between Lizard I., in the northern Great Barrier Reef, to Cape Moreton, off Brisbane between 1987 and 1989. Additionally, one striped marlin, *Tetrapterus audax*, and 3 blue marlin, *Makaira mazara*, were obtained from Cape Moreton waters.

Fish were dissected as described in Speare (1994). Several parasites could be identified from remnants remaining after their death. In these instances, live and dead specimens were distinguished. Didymozoids which were present as immature and mature cysts were enumerated from a subsample of fish. Two parasite species were prevalent on the gill filaments; counts were

made from each hemibranch of several fish with sufficient numbers of the parasites to supply distributional information. Where food items were readily identifiable, their prevalence and numerical abundance were recorded. Specimens were stored in 10% buffered neutral formalin or 70% ethanol.

RESULTS

A total of 35 parasite species were recorded from 52 sailfish (31 species) and 63 black marlin (28 species) (Table 1) [these figures are revised from those published in Speare (1994, 1995) but do not impact on these earlier publications]. Twenty-four species were common to both sailfish and black marlin. There was no significant correlation between total parasite numbers and fish size but, among sailfish the larger infections occurred among the heavier fish, whereas the small and immature black marlin included fish more heavily parasitised than any of the large adults (Fig. 1). There was little difference in the distributions of the major taxa between the 2 hosts with the exception of substantially more cestodes in sailfish (Fig. 2).

ACANTHOCEPHALA. One specimen of *Rhadinorhynchus pristis* was collected from the intestine of a sailfish at Cape Bowling Green in 1987 (Table 1). This species had not been recorded prior to this study from Pacific sailfish or black marlin, but is recorded from *Istiophorus albicans*, the Atlantic sailfish, in the Gulf of Mexico (Luhe, 1911).

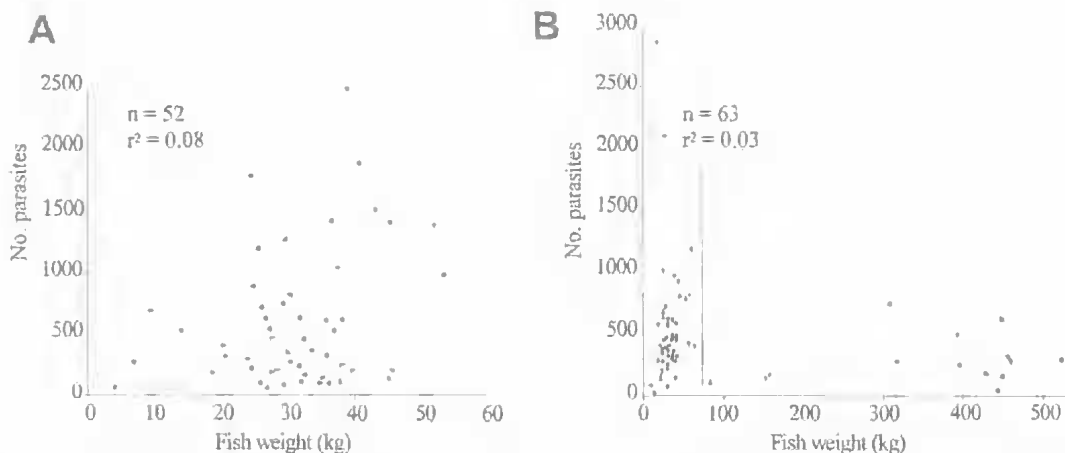


FIG. 1. Relationship between fish weight and total number of parasites for sailfish (A) and black marlin (B). Vertical line in B indicates the transition between immature and mature males which coincides with migration from nearshore shallow coastal to offshore oceanic waters.

CESTODA. *Bothriocephalus manubriiformis* is very widespread and host specificity presently extends to 8 of the 12 species of billfish (Xiphiidae and Istiophoridae). All species of trypanorhynchs had not been recorded in these hosts prior to this study. *Callitetrarhynchus gracilis*, *Floriceps ninuacanthus*, *Otobothrium dipsacum* and *Pterobothrium heterocanthum* were collected from black marlin and sailfish and *Otobothrium* sp. and *Nybelinia* sp. occurred only in sailfish.

Trypanorhynchs were generally of low intensity except *Otobothrium* sp. which had a mean intensity of 150 per sailfish in the Whitsundays (Table 2). The pyloric caecum was the preferred site for this parasite, which was particularly abundant in fish which had fed on pelagic triggerfish, *Balistoides* sp.

COPEPODA. *Caligus* sp. was restricted to the gill filaments of all fish except Lizard I. black marlin (Table 2). They were most abundant among sailfish from Cape Moreton where all fish were infected at an average of 138.8 ($n = 19$). The number of *Caligus* sp. on the gills of sailfish ($n = 8$) and black marlin ($n = 6$) was recorded for each hemibranch. This copepod displayed a preference for aggregating on hemibranchs 5 to 8 with the majority aggregated on a pair of opposing hemibranchs, especially towards the ventral anterior aspect of a hemibranch (Fig. 3). Localised erosion of the epithelium was evident where this parasite aggregated.

Gloiopotes huttoni was least prevalent on adult black marlin from Lizard I. but could otherwise

be considered as ubiquitous. The pennellid, *Pennella instructa*, was predominantly buried in the muscle dorsally. It was more prevalent among sailfish than black marlin and especially fish from Cape Moreton. Infrequently, *P. instructa* passed through the peritoneum and into an ovary and effectively blocked the lumen.

Counts of *P. instructa* differentiated live parasites as well as remnants of the cephalothorax surrounded by scar tissue. One percent of all pennellids in black marlin were remnants, whereas this figure was 65% in sailfish. Undeveloped female *P. instructa* occurred only on black marlin from Lizard I. in 1988 (spring). Where several pennellids were present on a fish, there was a tendency to aggregate. Information on group size was collected from 4 sailfish and 9 black marlin (Fig. 4). The most frequent grouping was 1 and the median group size was 2. Among fish with heavy infections of *P. instructa*, up to 24 copepods were closely attached. In the instance of a black marlin from Dunk I., where 132 pennellids were attached in groups of 3 to 24, severe localised muscle necrosis was observed. This fish, which weighed 38 kg, had a lowerjaw fork length of a 50 kg fish, indicating considerable loss of condition (Fig. 5).

One specimen of *Philichthys xiphiæ* (female) was collected from a depression in the right frontal bone of a sailfish from Cape Moreton in 1989. It had previously been recorded from broadbill, *Xiphias gladius*, with the latest record in 1913 (Scott & Scott, 1913). If Thomson's

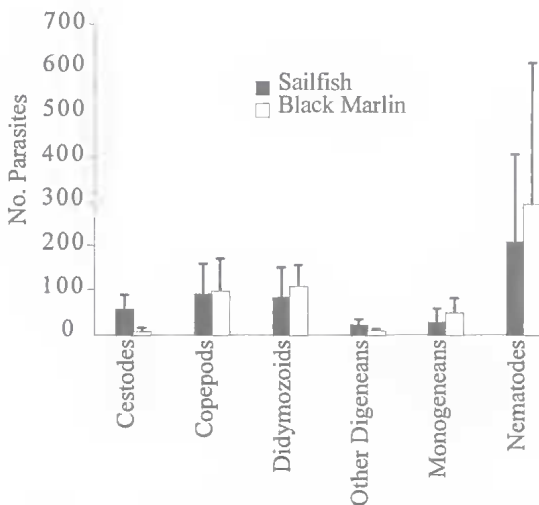


FIG. 2. Average number of parasites (+1SD) of the major taxa collected from sailfish (n = 52) and black marlin (n = 63).

(1889) record from New Zealand is discounted (as argued by Kabata, 1979), then it is also the first record from the Pacific Ocean.

DIGENEA. Twelve species of digeneans were recorded in black marlin and 13 in sailfish. With the exception of *Cardicola* sp., all digeneans recorded in black marlin also occurred in sailfish. Didymozoids were the most diverse group of parasites collected from these hosts (10 species). Two metacercariae, recognised as *Neotorticaecum* (Kurochkin and Nikolaeva, 1978) and *Torticaecum* (Yamaguti, 1971), were collected from the stomachs of sailfish.

Glomeritrema subcuticola was distributed almost exclusively on the head and inferior to the pseudobranchs where they were often densely aggregated. On the head, they overlaid the frontal and sphenotic bones. Both live and dead parasites were distinguished for 27 black marlin. While total counts were only slightly correlated with fish weight ($r^2 = 0.16$), the proportion of live cysts was highly negatively correlated ($r^2 = -0.82$) with fish weight (Fig. 6). Large fish from Lizard I. had proportionately fewer viable cysts than juvenile black marlin from nearshore waters although, on average, they had more cysts. Extensive ulceration, attributed to *G. subcuticola*, was observed below the pseudobranchs of 2 juvenile black marlin taken over the summer months off Cape Moreton (Fig. 7).

Makairatrema musculicola was more

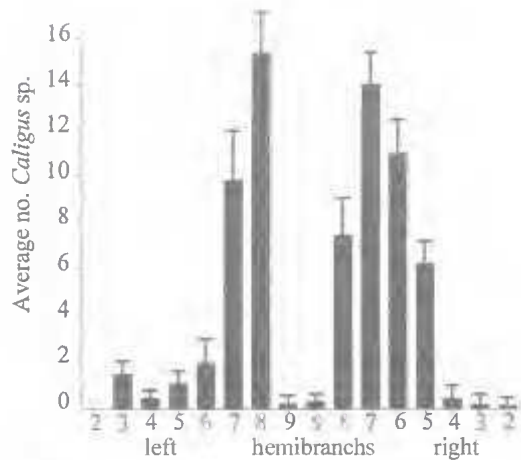


FIG. 3. Average distribution of *Caligus* sp. on the gills of sailfish (n = 8) and black marlin (n = 6). This copepod selected hemibranchs 5 to 8 and was usually aggregated on the antero-ventral section of the gills. The numerals on the X axis indicate hemibranchs from left to right side.

prevalent and with higher intensities of infection in sailfish than black marlin. Only black marlin from Cape Bowling Green were infected (9.1%) whereas sailfish from Cape Bowling Green and Cape Moreton had infections ranging up to 67 parasites (Table 2). This parasite was very discrete in its distribution on the host; subdermal cysts were exclusive to the dorsal body immediately inferior to the first dorsal fin. All cysts were well developed or spent and with a patent external pore suggesting reproductive activity (Fig. 8). *M. musculicola* had only previously been recorded from black marlin in Hawaii where it was encysted in the ventral abdominal muscle (Yamaguti, 1970), a site from which only *Neodidymozoon macrostoma* was taken in this study.

Neodidymozoon macrostoma was encapsulated towards the anterior half of the fish and especially about the lateral line/red muscle, fin membranes and the buccal cavity. This parasite, when mature, could be detected as a raised lump under the skin or through locating a small pore on the skin of the fish. Data were collected on the occurrence of immature (no eggs), mature and dead *N. macrostoma* from 39 black marlin (Fig. 9). Immature cysts occurred in fish from Cairns, Dunk I., Cape Bowling Green and Cape Moreton, at up to 25% of infection levels. The majority of parasites were alive at these localities whereas at Lizard I., approximately 50% were dead and there were no immature cysts.

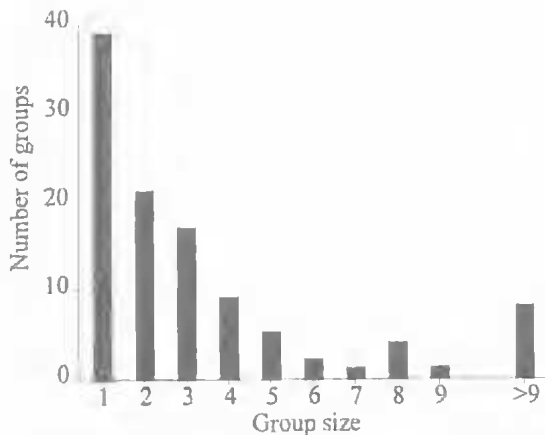


FIG. 4. Frequencies of group size of *Pennella instructa* on sailfish ($n = 4$) and black marlin ($n = 9$) from Queensland coastal waters. Median group size was 2 copepods.

Metadidymozoon branchiale was, on occasion, abundant on sailfish. Over 1000 pairs of this parasite were collected from the gills of a sailfish at Cape Moreton. It was not recorded among Lizard I. black marlin. This parasite, unlike *Caligus* sp., did not display a marked preference for specific hemibranchs.

Neodidymozoides microstoma was encapsulated in the pyloric caeca of 2 sailfish. All parasites were dead in the sailfish from Cape Bowling Green whereas they were alive in the Cape Moreton fish and measured between 15 and 50mm in diameter. Yamaguti (1970) recorded this didymozoid from striped marlin, *Tetrapterus audax*, black marlin and shortbilled spearfish, *T. angustirostris*, in Hawaii where it was parasitic on the serosa of the pyloric caecum. It occurred in a blue marlin, *Makaira mazara*, taken at Cape Moreton in this study (Table 1).

Cardicola grandis parasitised the heart and ventral aorta of sailfish and black marlin from each area. *Cardicola* sp. was collected from a black marlin at Lizard I. and a blue marlin at Cape Moreton. The afferent branchial arteries were isolated and dissected out of several fish but, few *C. grandis* were collected from these arteries suggesting that this parasite is specific to the ventricle and ventral aorta. Only 1 specimen of *Hirudinella marina* was collected from a sailfish whereas 73% of black marlin from Lizard I. were infected. Thus, it was essentially absent from sailfish and juvenile black marlin in the shallow nearshore areas.

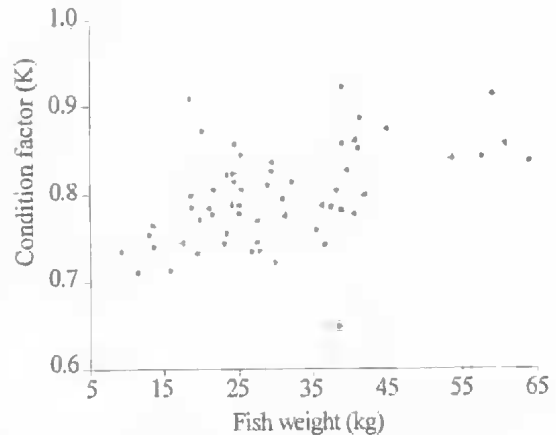


FIG. 5. Condition factor (K) for small, predominantly juvenile, black marlin ($n = 59$) from nearshore Queensland coastal waters. A fish () with a heavy infestation of *Pennella instructa* had a lower K value than all other fish. $K = 100 \times Wt/LJFL^3$ (units in gm and cm).

MONOGENEA. Four species of monogenea were parasitic on black marlin. *Capsaloides cristatus* was on the gills of 1 black marlin from Cape Moreton. *Capsaloides istiophori* was collected from the gill filaments of both sailfish and black marlin (Table 1). It was particularly prevalent and abundant among sailfish from Cape Moreton and was not recorded, as was *C. tetrapteri*, on any black marlin north of Cape Bowling Green (Table 2).

Tristomella pricei was ubiquitous, occurring on all black marlin and between 33% and 90% of sailfish on an areal basis. While it was predominant on the skin of sailfish and juvenile black marlin, it was restricted to the buccal cavity of mature black marlin from Lizard I. (Fig. 10). Where it aggregated on the fish, there was extensive dermal erosion and *Gloiopotes huttoni* was often similarly aggregated at these sites.

NEMATODA. Four species of adult nematodes were identified from the stomach and intestinal lumen of black marlin (3 species) and sailfish (2 species). These parasites were identified by Bruce and Cannon (1989) and no attempt was made to enumerate their individual distributions due to the intensive microscopic work required to do so. Larvae were also in the stomach mucosa (probably *Contracaecum* sp.) and encapsulated in the intestinal serosa. Billfish have the capacity to fully evert the stomach as there are no mesenteries directly attached to it. This behaviour is

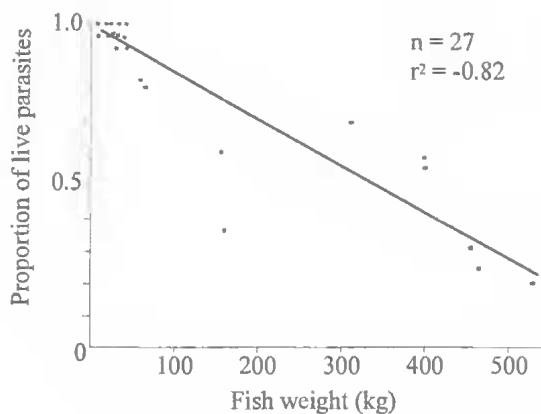


FIG. 6. The relationship between the proportion of live cysts of *Glomeritrema subcuticola* and fish weight was highly negatively correlated in black marlin indicating a more recent exposure to infection among the small juvenile fish in nearshore coastal waters.

readily encountered during sportfishing and may be a stress response but, additionally, may serve to evacuate bones and perhaps rid the animal of parasites of the lumen. A juvenile black marlin from Cape Bowling Green had suffered some form of trauma resulting in the stomach becoming attached to the ventral body wall. This effectively precluded eversion of the stomach which contained 854 nematodes whereas the average infection for black marlin was $33.2 (\pm 130.8)$.

BLUE MARLIN AND STRIPED MARLIN. Bruce & Cannon (1989) described 2 new species of nematodes in striped marlin from material collected in this study. Also, an undescribed sanguinicolid, *Cardicola* sp. was parasitic in the heart and ventral aorta of 2 of the 3 blue marlin dissected. All other parasites collected from these fish were also in sailfish and black marlin (Table 1).

FEEDING ECOLOGY. Thirty-four sailfish were examined for recognisable food items in the stomach. Pilchards, *Amblygaster sirm*, and long-toms, *Tylosurus* sp., were present in 57% of stomachs. Pelagic triggerfish, *Balistoides* sp., and toadfish, (Tetraodontidae), were numerically abundant but occurred only in fish from the Whitsundays and Cape Moreton, respectively. Among the 41 juvenile black marlin from the nearshore fishing grounds, pilchards, *Amblygaster sirm*, and herrings, *Sardinella gibbosa*, accounted for 93% of all food items and occurred in 85% of stomachs. *Sarda* sp. were only in Cape Moreton fish stomachs. Pilchards were, by far, the most abundant and prevalent prey of marlin from

nearshore coastal waters (Table 3). Lizard I. black marlin stomachs were invariably empty which, in some instances, was clearly due to evacuation of the stomach while the fish was being caught. Remnants of other billfishes were taken from the stomach wall of 4 of the 13 Lizard I. fish.

DISCUSSION

The parasites recorded in this study significantly increase the number of parasites recorded from sailfish and black marlin. The parasite fauna of sailfish, prior to this study, was much better known than that of black marlin.

Larval trypanorhynchids quite often parasitise a wide range of hosts and it is not surprising to document additional hosts for the species collected in this study. *Callitetrarhynchus gracilis* is reported from approximately 20 fishes and *Floriceps minacanthus* from at least 6 fishes. Evidence suggests that there is little host specificity at the level of the second intermediate host. For example, *F. minacanthus* has previously been recorded from coral trout, *Plectropomus leopardus*, and flathead, *Platycephalus laevis*, as well as barracuda, *Sphyrna novaehollandiae*.

The large numbers of *Otobothrium* sp. collected from the pyloric caeca of sailfish from the Whitsundays may be related to feeding on *Balistoides* sp. There were many blastocysts in the stomachs of these fish although, it is not known whether the source is the trigger fish itself or its food which would include copepods.

The three frequently recorded parasitic copepods were widely distributed among sailfish and black marlin. The most conspicuous feature of these distributions was the absence of *Caligus* sp. from Lizard I. black marlin. Additionally, this parasite was unevenly distributed on the gill filaments of the host. Benz & Dupre (1987) found that the abundance of *Kroyeria carchariaeglauci* increased with the surface area of the gills of the blue shark, *Prionace glauca*, which may have simply been due to an increase in the availability of suitable habitat. The distribution of parasites on the gills is generally believed to be related to respiratory water flow (e.g. Fryer, 1968; Hanck & Fernando, 1978) but, distribution varies among copepod species which suggests additional factors are involved (see Rohde, 1979). The absence of *Caligus* sp. from Lizard I. fish may be related to the availability of suitable habitat. As black marlin age, the gill lamellae become increasingly calcified which may render the gills unsuitable

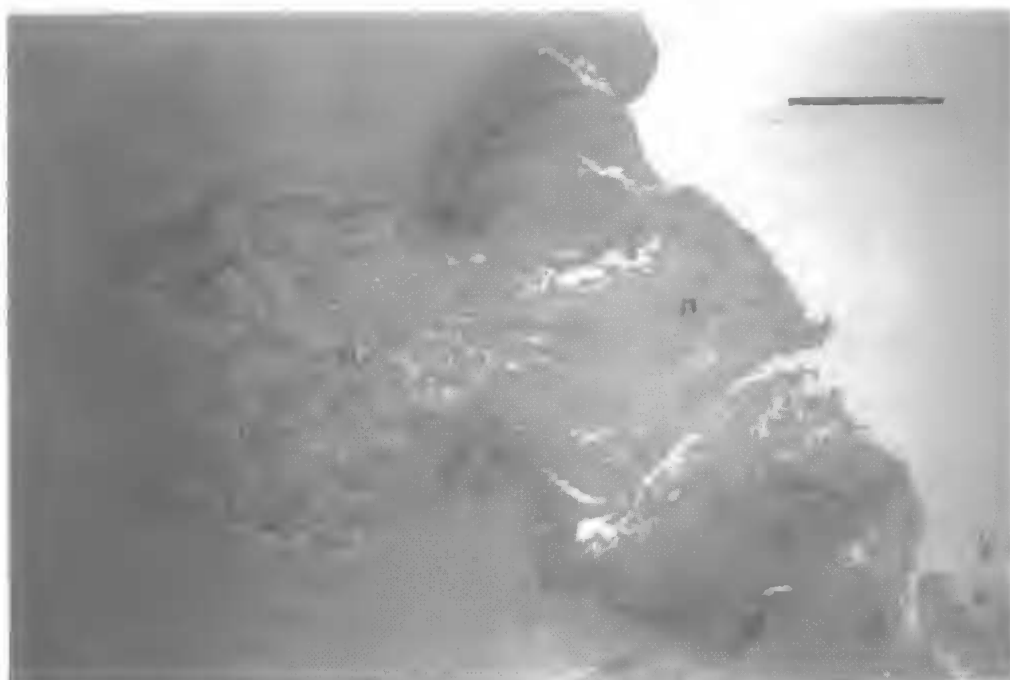


FIG. 7. Photomicrograph of *Glomeritrema subcuticola* and overlying necrotic tissue presumably as a consequence of the capsule rupturing. d = dermis, n = necrotic tissue, p = parasite. Scale bar = 1mm.

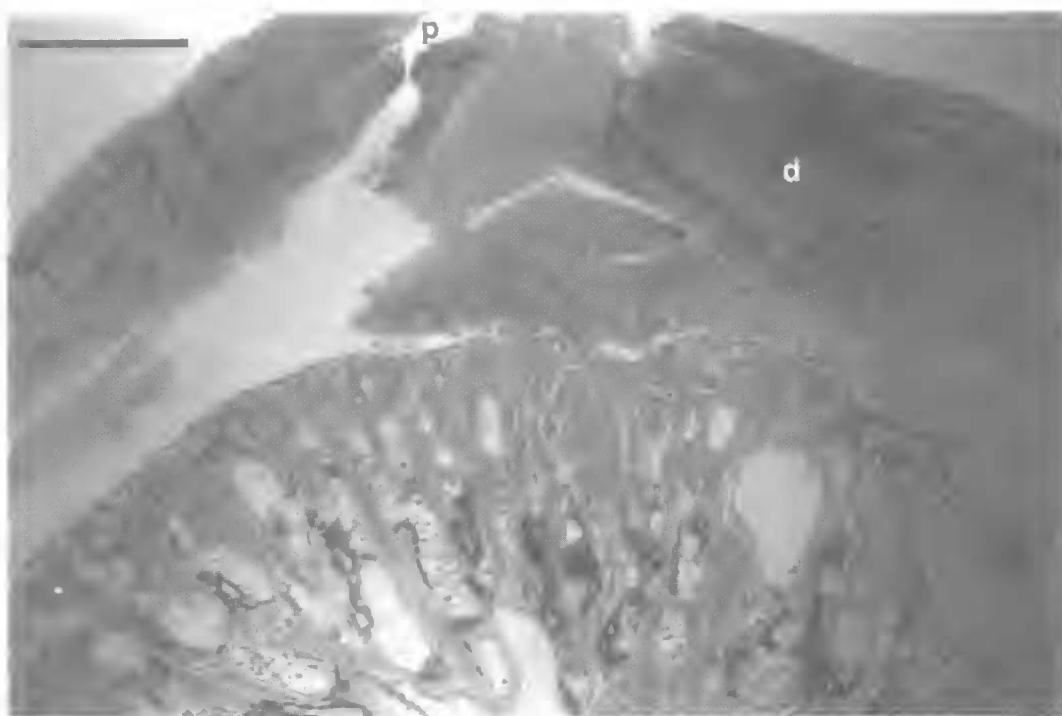


FIG. 8. Cyst of the didymozoid, *Makairatrema musclicola*, displaying a conspicuous external pore. d = dermis, o = ovary, p = pore. Scale bar = 2mm.

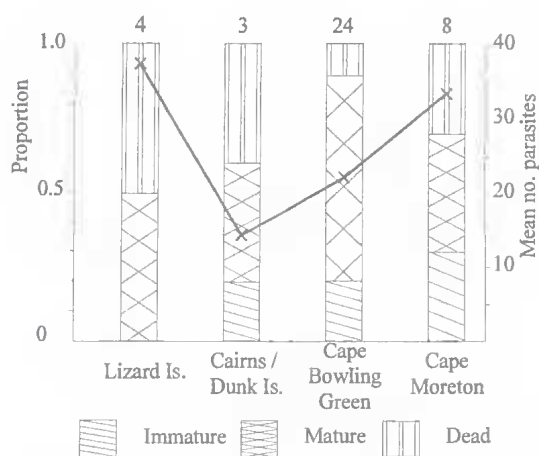


FIG. 9. Proportion of immature, mature and dead cysts of *Neodidymozoon macrostoma* on black marlin indicated continued exposure to infection among juveniles in nearshore waters and lack of recent reinfection among mature offshore fish (Lizard I.). Mean number of parasites per infected fish is shown on the right hand axis and the numbers of marlin from which this information was collected is shown above the bars.

for attachment and feeding. Such ontogenetic changes may also explain the absence of *Metadidymozoon branchiale* from the gills of these large fish, whereas up to 70% of juveniles were infected. In contrast, *Tristomella pricei* numbers were positively correlated with the size of black marlin ($r^2 = 0.24$). Also, this parasite was predominant in the mouth of the large fish whereas its preference was the external body surface of juvenile fish. This aggregation in the buccal cavity of large marlin may represent a move to a more favourable habitat than is available with the tougher and thicker skin found on the adult.

Distributions of *T. pricei* and *Gloiopotes huttoni* on black marlin were not correlated ($r^2 = 0.05$) but there was evidence of co-occurrence on sailfish ($r^2 = 0.23$). While data were not collected, it was visually evident that a densely aggregated group of *T. pricei* often included a similar aggregation of *G. huttoni* on sailfish. *T. pricei* feeding activities in these observations were responsible for severe erosion of the dermis and this activity may present an opportunity of enhanced feeding for *G. huttoni*.

Pennellids have been reported as pathogenic even at very low levels of infection (Kabata, 1958). Where *P. instructa* had penetrated the ovaries of sailfish, histology did not reveal a reduction in reproductive ability. Alternately, the

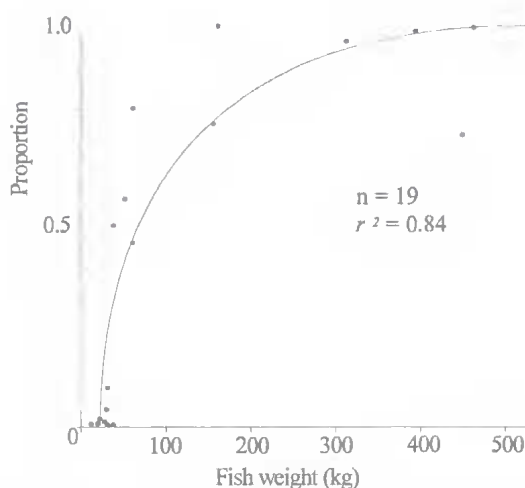


FIG. 10. Proportion of the total infection of *Tristomella pricei* inhabiting the buccal cavity of black marlin. There was a dramatic shift in the predominant site of infection with the size of the fish.

heavily parasitised black marlin from Dunk I. had shed approximately 25% of its body weight indicating a substantial impact from this infection.

The far greater incidence of dead parasites embedded in the flesh of sailfish, as opposed to black marlin, may be related to the respective ages of these fishes. A sailfish of 30kg may be 5 or 6 years old whereas a black marlin of this size would be less than 3 years of age. Consequently, among fish of comparable size, sailfish have been exposed to infection for considerably longer periods which are well beyond the life-span of the parasite.

Philichthys xiphiae is a particularly rare parasite. It is the only representative of a genus belonging to a small family (approximately 38 species) of endoparasitic copepods. Kabata (1979) documents it as a parasite of the ducts and sinuses in the frontal bones of broadbill, *Xiphias gladius*. Its recorded distribution in this host is restricted to the Kattegat (Bergsoe, 1864), the western Mediterranean (Brian, 1905), the Adriatic Sea (Valle, 1890), the Belgian coast (Beneden, 1861), Martha's Vineyard (Wilson, 1932) and England (Scott & Scott, 1913). The present record confirms this parasite's high degree of site specificity and the probability, as with other species of copepod, of its occurrence in other species of billfish.

Didymozoids were the best represented family of parasites collected from sailfish and black marlin. Didymozoids have a tropical and

subtropical distribution (Yamaguti, 1970; Hewitt & Hine, 1972; Margolis & Arthur, 1979). They are particularly prevalent among tuna. For example, 37 species are recorded from yellowfin tuna, *Thunnus albacares*, 33 from skipjack, *Katsuwonus pelamis*, 25 from bigeye tuna, *Thunnus obesus*, and 16 from albacore, *Thunnus alalunga* (see Nikolaeva, 1985). Among the istiophorids, 6 species of didymozoids are recorded from Atlantic blue marlin, *Makaira nigricans*, 4 from striped marlin, *Tetrapterus audax*, and 2 from short-billed spearfish, *T. angustirostris*. These figures are still low in comparison with tunas and probably reflect a lack of widespread geographical examination of these fishes' parasite fauna and inspection of tissues where didymozoids typically encapsulate.

Lester (1980) considered that the release of eggs through ulceration of the overlying dermal tissue may be widespread among didymozoids. The ulceration associated with *Glouieritrema subcuticola* was observed in juvenile black

marlin and was, therefore, not associated with host spawning as suggested for *Neometadidymozoon heliciis*. Adult fish off Lizard I. only had infections of mature, gravid or dead parasites in the spring spawning months. The occurrence of a small 'pin prick' hole above gravid *Neodidymozoon macrostoma* and a more obvious patent external pore associated with gravid *Makaira-trema musculicola* suggest a possible mechanism for the release of eggs in these didymozoids.

An hypothesis of southerly migration of juvenile black marlin is supported by an increase in the average size of fish with latitude, movements of tagged fish and a seasonal shift in the availability of fish to recreational game fishers (Pepperell, 1989). Parasitological data (Speare, 1994) suggests a common stock of juvenile black marlin on the east coast. The average intensity of infection and incidence of immature *Neodidymozoon macrostoma* on juvenile black marlin appeared to increase with latitude (refer to Fig. 9) and, coupled with similar prevalence on each fishing

TABLE 1. Parasite species collected from billfishes in Queensland coastal waters. Sa = sailfish, Bk = black marlin, Bl = blue marlin, St = Striped marlin. * new host record for black marlin, † new host record for sailfish, # new host record for blue marlin, ‡ non-parasitic on host. AHC = Australian Helminth Collection, South Australian Museum; QM = Queensland Museum, Brisbane; SAM = South Australia Museum.

Parasite	Authority	Host	Accession numbers
ACANTHOCEPHALA			
RHADINORHYNCHIDAE			
<i>Rhadinorhynchus pristis</i> *	Luhe, 1911	Sa	QMG212206
CESTODA			
BOTHRIOCEPHALIDAE			
<i>Bothriocephalus manubriiformis</i>	Linton, 1889	SaBk	
DASYRHYNCHIDAE			
<i>Callitetrarhynchus gracilis</i> * † #	Rudolphi, 1819	SaBkBl	QMG212785, SAM17410, 17417, 18495, 18496
<i>Floriceps minacanthus</i> * †	Campbell & Beveridge, 1987	SaBk	AHC17411, 17414
OTOBOTHRIDAE			
<i>Otobothrium dipsacum</i> * † #	Linton, 1897	SaBkBl	QMG212165, 212166, 212798, 212799, 212800
<i>Otobothrium</i> sp. †		Sa	
PTEROBOTHRIDAE			
<i>Pterobotrium heterocanthum</i> †	Diesing, 1850	SaBk	QMG212801, 212802
TENTACULARIIDAE			
<i>Nybelinia</i> sp. †		Sa	
COPEPODA			
CALIGIDAE			
<i>Caligus</i> sp. * †		SaBk	
EURYPHORIDAE			
<i>Gloiopotes huttoni</i>	(Thomson, 1889)	SaBkBlSt	
PENNELLIDAE			
<i>Pennella instructa</i>	Wilson, 1917	SaBkSt	
PHILICHTHYIDAE			
<i>Philichthys xiphiae</i> †	Steenstrup, 1861	Sa	
CRUSTACEA			
LEPADIDAE			
<i>Conchoderma virgatum</i> * ‡	(Spengler, 1790)	SaBk	
DIGenea			
ACANTHOCOLPIDAE			
<i>Stephanostomum larva</i> * †	Looss, 1899	SaBk	

TABLE 1 (cont.)

DIDYMOZOIDAE			
<i>Angionematothrium jugulare</i> *	Yamaguti, 1970	SaBk	
<i>Glomeritrema subcuticola</i> * †	Yamaguti, 1941	SaBk	QMG212173, 212789
<i>Makairatrema musclicola</i> † #	Yamaguti, 1970	SaBkBl	QMG212178, 212201, 212791, 212792
<i>Metadidymozoon branchiale</i>	Yamaguti, 1970	SaBk	QMG212202, 212793
<i>Neodidymozoides microstoma</i> †	Yamaguti, 1970	SaBl	QMG212168, 212169, 212796, 212797
<i>Neodidymozoon macrostoma</i> * †	Yamaguti, 1970	SaBkBl	QMG212174, 212175, 212203, 212204, 212795
<i>Nematothrium</i> sp. A * †		SaBk	
<i>Nematothrium</i> sp. B * †		SaBk	QMG212794
<i>Neotorticaecum</i> larva †	Kurochkin & Nikolaeva, 1978	Sa	
<i>Torticaecum</i> larva * †	Yamaguti, 1971	SaBk	
HIRUDINELLIDAE			
<i>Hirudinella marina</i> * †	(Garcin, 1730)	SaBk	QMG212790
SANGUINICOLIDAE			
<i>Cardicola grandis</i> † #	Lebedev & Mamaev, 1968	SaBkBl	QMG212205, 212783, 212784
<i>Cardicola</i> sp. * † #		BkBl	QMG212786, 212787
MONOGENEA			
CAPSALIDAE			
<i>Capsaloides cristatus</i> *	Yamaguti, 1968	Bk	QMG212782
<i>Capsaloides istophori</i> *	Yamaguti, 1968	SaBk	QMG212195
<i>Capsaloides tetrapteri</i> * † #	Yamaguti, 1968	SaBkBl	QMG212196, 212197, 212788
<i>Tristomella pricei</i>	Price, 1960	SaBkBlSt	QMG212198, 212199, 212200, 212803, 212804
NEMATODA			
SPIRURIDAE			
<i>Camallanus</i> sp. * †		SaBk	QMG212780, 212781
ANISAKIDAE			
<i>Hysterothylacium pelagicum</i>	Deardorff & Overstreet, 1982	Bk	QMGL10113
<i>Maricostula cenatica</i>	Bruce & Cannon, 1989	Si	QMGL10140
<i>Maricostula histiophori</i>	(Yamaguti, 1935)	Sa	QMGL10114, 10115
<i>Maricostula makairi</i> *	Bruce & Cannon, 1989	Bk	QMGL10111, 10112
<i>Maricostula tetrapteri</i>	Bruce & Cannon, 1989	St	QMGL10143

ground (Table 1), indicates continuous exposure and accumulation with latitude (= time). That is, the distribution of *Neodidymozoon macrostoma* is consistent with southerly migration of juvenile black marlin between Cairns and Cape Moreton. Also, adult black marlin are not infected in the extra-reefal waters adjacent to Lizard I. but acquire their infections elsewhere, preceding arrival in these waters by a period exceeding that required for the parasite to mature.

The black marlin, with an unusually high infection of nematodes and its stomach unable to be everted, had been previously captured (59 days earlier) and discussions with the person who had first captured this fish indicated that the damage was inflicted by a tagging pole penetrating the body cavity. The infection may, therefore, have accumulated over this short period and the anatomy of these fishes suggests a mechanism, the ability to evert the stomach, for the removal of parasites (and perhaps fish bones, etc).

Sailfish and juvenile black marlin are seasonally abundant in areas where large mixed schools of baitfish occur in the shallow nearshore waters (Williams, 1990). These schools are dominated

by pilchards, *Amblygaster sirm*, herrings, *Sardinella* spp., and yakkas, *Decapterus* sp. Black marlin were more likely to select pilchards from these schools whereas sailfish were far less likely to do so. In general, sailfish had a more diverse feeding strategy than black marlin which may account for their more diverse parasite fauna.

The parasites identified from striped and blue marlin, through less exhaustive dissections, demonstrate the likelihood of parasite faunas from these fish showing similarities to those of sailfish and black marlin.

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TABLE 2. The prevalence (P - %) and mean intensity (I), with associated standard deviation (SD) and range (RA), for each parasite infecting black marlin and sailfish from fishing grounds along the Queensland coast.

Parasites of Black Marlin	Cape Bowling Green n = 33				Cape Moreton n = 11				Cairns n = 2		Dunk Island n = 4				Lizard Island n = 13			
	P	I	SD	RA	P	I	SD	RA	P	RA	P	I	SD	RA	P	I	SD	RA
<i>Bothriocephalus manubriiformis</i>	71.9	6.3	7.2	1-33	72.7	4.5	3.0	2-10	50	3	100	6.3	6.6	2-16	27.3	6.3	5.5	1-12
<i>Callitetrarhynchus gracilis</i>	6.1	5.5	3.5	3-8	9.1	1.0			0		0				7.7	1.0		
<i>Floriceps minacanthus</i>	48.5	2.8	2.1	1-8	54.5	3.7	3.0	1-9	50	6	50.0	3.5	3.5	1-6	15.4	4.0	4.2	1-7
<i>Otobothrium dipsacum</i>	12.1	1.5	0.6	1-2	9.1	1.0			0		0				38.5	2.0	1.0	1-3
<i>Pterobothrium heterocanthum</i>	6.1	4.0	4.2	1-7	0				0		0				0			
<i>Caligus</i> sp.	87.1	11.0	9.6	1-41	80.0	28.5	17.4	11-60	50	2	50.0	4.5	3.5	2-7	0			
<i>Gloiopotes huttoni</i>	93.9	93.2	132.0	3-736	100	117.5	81.9	6-329	50	24	100	57.5	56.0	7-107	76.9	67.9	46.5	2-141
<i>Pennella instructa</i>	21.2	16.4	24.1	1-66	36.4	6.3	4.3	2-12	0		50.0	67.5	91.2	3-132	46.2	24.0	29.7	4-82
<i>Conchoderma virgatum</i>	3.0	26.0			9.1	21.0			0		25.0	9.0			15.4	5.5	4.9	2-9
<i>Angionemato-bothrium jugulare</i>	3.0	1.0			9.1	3.0			0		25.0	6.0			0			
<i>Glomeritrema subcuticola</i>	93.9	62.5	35.6	15-132	100	72.3	56.0	11-211	100	55-122	100	42.5	19.8	16-64	84.6	202.3	192.5	55-660
<i>Makairatrema musculicola</i>	9.1	3.0	3.5	1-7	0				0		0				0			
<i>Metadidymozoon branchiale</i>	24.2	11.3	19.2	1-58	63.6	15.9	18.0	2-48	0		25.0	1.0			0			
<i>Neodidymozoon macrostoma</i>	87.9	20.7	26.9	1-128	90.9	32.8	23.3	14-77	100	10-30	100	9.5	9.6	2-22	38.5	37.8	32.4	1-79
<i>Nematobothrium</i> sp. A	15.2	3.8	4.1	1-11	27.3	2.7	1.5	1-4	0		75.0	3.3	2.5	1-6	0			
<i>Nematobothrium</i> sp. B	24.2	4.3	2.9	1-10	36.4	7.5	6.1	2-15	100	4-5	100	3.8	1.9	1-5	15.4	3.5	2.1	2-5
<i>Torticaecium</i> larva	3.0	1.0			0				0		0				0			
<i>Hirudinella marina</i>	0				0				0		0				61.5	5.9	5.6	1-17
<i>Cardicola grandis</i>	45.5	2.1	2.1	1-8	45.5	2.0	2.2	1-6	0		0				7.7	5.0		
<i>Capsaloides cristatus</i>	0				9.1	7.0			0		0				0			
<i>Capsaloides istiophori</i>	12.1	2.5	2.4	1-6	40.0	63.0	85.0	11-190	0		0				0			
<i>Capsaloides tetrapteri</i>	3.0	24.0			10.0	1.0			0		0				0			
<i>Tristomella pricei</i>	93.9	17.1	22.2	1-89	100	86.8	72.5	10-245	100	21-32	100	75.3	89.6	22-209	84.6	77.7	65.7	14-253
<i>Camallanus</i> sp.	33.3	3.0	2.1	1-8	0				100	1	50.0	3.5	0.7	3-4	15.4	1.0	0.0	
Adult nematodes	63.6	88.7	221.1	1-854	81.8	14.0	12.4	1-43	50	16	100	2.8	2.2	1-6	30.8	19.0	10.9	9-33

Parasites of Sailfish	Cape Bowling Green n = 24				Cape Moreton n = 19				Dunk Island n = 3		Whitsundays n = 6			
	P	I	SD	RA	P	I	SD	RA	P	RA	P	I	SD	RA
<i>Rhadinorhynchus pristis</i>	4.2	1.0			0				0		0			
<i>Bothriocephalus manubriiformis</i>	83.3	8.7	12.5	1-55	100	66.0	107.3	3-471	100	4-74	100	19.2	20.6	2-58
<i>Callitetrarhynchus gracilis</i>	8.3	4.5	2.1	3-6	11.1	1.5	0.7	1-2	33.3	24	16.7	9.0		
<i>Floriceps minacanthus</i>	50.0	14.9	11.7	2-34	16.7	9.0	13.9	1-25	66.7	8-19	100	13.7	10.9	2-32
<i>Otobothrium dipsacum</i>	29.2	9.7	15.5	1-44	5.3	1.0			33.3	3	66.7	7.3	10.0	1-22
<i>Otobothrium</i> sp.	0				0				0		83.3	150.0	130.9	7-267
<i>Pterobothrium heterocanthum</i>	4.2	1.0			0				0		16.7	1.0		

TABLE 2. (cont.)

Parasites of Sailfish	Cape Bowling Green n = 24				Cape Moreton n = 19				Dunk Island n = 3		Whitsundays n = 6			
	P	I	SD	RA	P	I	SD	RA	P	RA	P	I	SD	RA
<i>Nybelinia</i> sp.	12.5	3.3	3.2	1-7	5.3	19.0			0		50.0	29.3	6.7	25-37
<i>Caligus</i> sp.	82.6	39.3	31.1	2-97	100	138.8	142.6	6-443	100	3-6	83.3	80.0	75.2	4-193
<i>Gloiopotes huttoni</i>	90.5	16.8	12.6	2-48	92.9	17.0	13.7	2-49	100	6-10	100	57.0	63.8	8-153
<i>Pennella instructa</i>	33.3	3.5	3.5	1-10	84.2	8.4	7.3	2-26	33.3	4	66.7	5.3	7.2	1-16
<i>Conchoderma virgatum</i>	4.2	1.0			21.1	3.3	1.0	2-4	0		0			
<i>Stephanostomum</i> larva	0				0				0		50.0	9.3	6.1	4-16
<i>Angionemato-bothrium jugulare</i>	8.3	2.5	2.1	1-4	21.1	2.0	2.0	1-5	33.3	4	0			
<i>Glomeritrem a subcuticola</i>	4.2	1.0			0				0		0			
<i>Makairatrem a musculicola</i>	20.8	12.6	24.3	1-56	26.3	21.6	26.5	2-67	0		0			
<i>Metadidymozoon branchiale</i>	72.7	48.9	98.6	1-369	63.2	226.3	407.7	1-1226	0		60.0	24.3	13.7	15-40
<i>Neodidymozoon macrostoma</i>	75.0	7.3	9.7	1-42	89.5	10.2	12.5	2-47	66.7	1-3	50.0	2.7	2.1	1-5
<i>Nematobothriu</i> sp. A	47.4	5.4	5.0	1-15	61.1	4.3	3.3	1-13	66.7	2-3	33.3	3.5	0.7	3-4
<i>Nematobothriu</i> sp. B	8.3	2.5	2.1	1-4	36.8	2.0	1.0	1-4	33.3	1	16.7	2.0		
<i>Neotorticaecum</i> larva	0				0				0		16.7	6.0		
<i>Torticaecum</i> larva	16.7	5.8	4.0	1-10	0				33.3	2	50.0	6.3	3.2	4-10
<i>Hirudinella marina</i>	4.2	1.0			0				0		0			
<i>Cardicola grandis</i>	82.6	19.3	14.0	1-51	35.3	14.8	14.8	1-38	100	4-9	66.7	7.3	10.5	2-23
<i>Capsaloides istiophori</i>	42.9	7.3	7.0	1-23	78.9	51.0	64.9	2-194	0		40.0	29.5	20.5	15-44
<i>Capsaloides tetrapteri</i>	23.8	2.8	1.9	1-6	57.9	26.1	46.7	1-156	0		40.0	7.5	2.1	6-9
<i>Tristomella pricei</i>	55.0	9.9	8.5	1-24	86.7	13.9	15.5	1-47	33.3	1	60.0	1.3	0.6	1-2
<i>Camallanus</i> sp.	58.3	4.0	2.2	1-8	5.3	2.0			66.7	2-4	16.7	10.0		
Adult nematodes	66.7	28.9	93.9	2-381	73.7	3.0	2.6	1-11	100	1-5	66.7	43.3	29.6	2-70

TABLE 3. Stomach contents of sailfish and black marlin from Queensland coastal waters. Count is the number of food items of each category and (in brackets) the percentage contribution of that food item to the diet of all fish examined. Prevalence is the percentage of fish with that food item. * - includes bills and mandibles from LI fish with values based on LI fish only.

Sailfish (n=34)	Count (%)	Prevalence	Black marlin (n=41)	Count (%)	Prevalence
<i>Amblygaster sirm</i>	23 (3)	30	<i>Amblygaster sirm</i>	132 (78)	66
<i>Tylosurus</i> sp.	18 (2)	27	<i>Sardinella gibbosa</i>	25 (15)	19
<i>Balistoides</i> sp.	425 (49)	15	<i>Decapterus</i> sp.	4 (2)	7
<i>Sardinella</i> spp.	7 (1)	12	<i>Sarda</i> sp.	3 (2)	5
<i>Decapterus</i> sp.	5 (1)	9	<i>Carangoides</i> sp.	1 (1)	2
<i>Tetraodontidae</i>	373 (43)	6	<i>Chirocentrus dorab</i>	1 (1)	2
<i>Loligo</i> sp.	2 (1)	6	<i>Sphyraena</i> sp.	1 (1)	2
<i>Scomberoides</i> sp.	2 (1)	3	empty	- -	15
<i>Hyperlophus</i> sp.	3 (1)	3	billfish remains *	4 -	31
<i>Paramonacanthus</i> sp.	1 (1)	3			
<i>Lactoria</i> sp.	1 (1)	3			
empty	- -	6			

the US Helminthological Museum, Beltsville, Maryland. Billfish remains in the stomachs of black marlin were identified by Harry Fierstein (Biological Sciences Department, California Polytechnic State University, San Luis Obispo).

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